Tomas Davidovic
DFKI Saarbruecken
Saarland University
and CTU in Prague, FEE

Lukas Marsalek
Saarland University
and Charles University in Prague

Nicolas Maeding
IBM Deutschland
Research & Development
GmbH

Markus Kaltenbach
IBM Deutschland
Research & Development
GmbH

Peter-Hans Roth
IBM Deutschland
Research & Development
GmbH

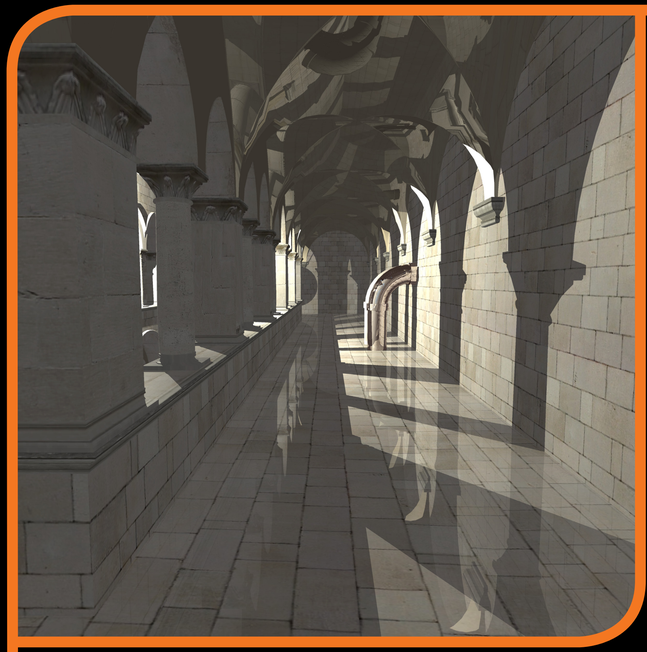
Philipp Slusallek
DFKI Saarbruecken
and Saarland University

Ray Tracing Element for Cell/B.E.™

Introduction

Using IBM 90 nm technology we synthesised a complete ray tracing element. The unit significantly accelerates the one task common for all ray tracers, finding the closest intersection.

To support any algorithm that benefits from this sampling method we propose separated shading and traversal. The design is evaluated within context of Cell Broadband Engine™ (Cell/B.E.), utilizing existing SIMD processors for shading.



Sponza: 187 MRays/s

From DRPU to RTE

The main problem:
Larger memory latency.
The changes:
More RTE threads to cover it.
Increases the latency of RTE itself.
Shading removed from the unit, handled by GP units, and connected via normal bus.
No special point-to-point connect.

Basic operation

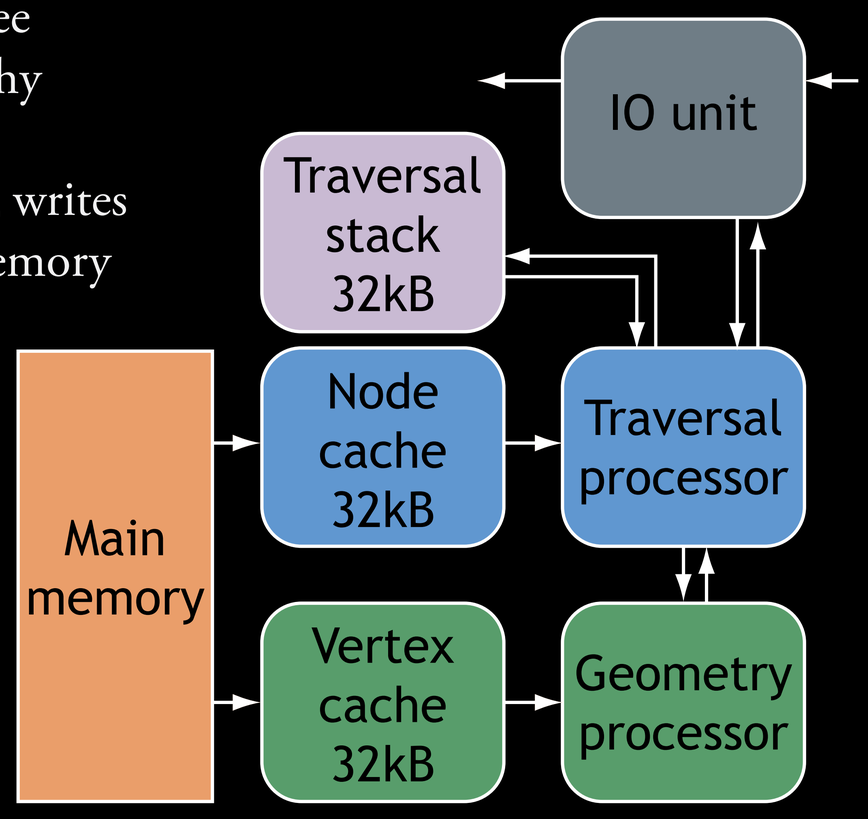
Shading processor generates four rays and sends them as a single query to RTE.
A free RTE thread picks up the query and:

- Traverses the rays through BKD tree
- Transforms them in 2-level hierarchy
- Intersects them with triangles

Upon finding the closest intersection, writes the result into shading processor's memory

Technologies

- **90 nm** synthesised in 90 nm process by IBM.
- **VHDL** for cycle accurate simulation of synthesised design.
- **SystemC** for system performance evaluation.



Conference: 159 MRays/s

Venice: 171 MRays/s

Results

Ray casting at **160 MRays/s**.
Throughput of **25 cycles/ray**.
Frequency up to **3.2 GHz**.
Area bellow one SPE of Cell/B.E.
Latency of 8-13k cycles and peak bandwidth requirements at 11 GB/s.

Conclusions

On the area of a single SPE we get **30 times** the traversal performance. Bandwidth and throughput are realistic on contemporary architectures.

Strict separation of shading and tracing requires new software model for a ray tracing applications. Newest experiments confirm viability.

Woop, S. 2006. DRPU: A Programmable Hardware Architecture for Real-time Ray Tracing of Coherent Dynamic Scenes. PhD thesis, Saarland University.
Benthin, C., Wald, I., Scherbaum, M., and **Friedrich, H.** 2006. Ray Tracing on the CELL Processor. In Proceedings of the 2006 IEEE IRT, 15–23.
Woop, S., Marmitt, G., and **Slusallek, P.** 2006. BKD Trees for Hardware Accelerated Ray Tracing of Dynamic Scenes. In Proceedings of Graphics Hardware.
IBM 2006. Cell Broadband Engine Programming Handbook. IBM Corporation.

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